## ADMINISTRATIVE INFORMATION

1. **Project Name:** High-Strength/High Alkaline Resistant Fe-Phosphate Glass Fibers as Concrete Reinforcement

2. **Lead Organization:** MO-SCI Corporation
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3. **Principal Investigator:** Dr. Mariano Velez
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4. **Project Partners:** University of Missouri-Rolla, Ceramic Engineering Dept.,
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Advanced Glassfiber Yarns, LLC
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5. **Date Project Initiated:** May 2004

6. **Expected Completion Date:** April 2007

## PROJECT RATIONALE AND STRATEGY

7. **Project Objective:** Investigate the use of alkaline-resistant Fe-phosphate (IP) fiberglass as concrete reinforcement, substituting silica-based alkali-resistant (AR) glass fibers. These IP fibers have a potential for 40-60% lower energy consumption during manufacturing as compared to silica-based AR glass fibers.

8. **Technical Barrier(s) Being Addressed:** The technical barriers are associated with the lack of having enough data on the properties of these new IP glass compositions (i.e., viscosity). A second barrier is that there is no current industrial/commercial manufacturing of IP glass fibers.

9. **Project Pathway:** Selected IP glass compositions will be used for applied research, properties determination, and their optimization. Melting will be done in lab scale by electric means and final procedure will be transferred to the industrial partner (Advanced Glassfiber Yarns, LLC). The best IP glass compositions will be used as concrete reinforcement and tested according to industry standards. The results will be compared to the use of concrete reinforced with AR silica-based fibers.

10. **Critical Technical Metrics:** Success will be indicated by obtaining IP glass fibers that can readily substitute current silica-based AR glass fibers. This IP glass would need to show high chemical durability, good mechanical properties, and adequate viscosity-temperature behavior for pulling glass fibers:

    1. Obtaining chemical durability better than commercial AR silica-based glass fibers
    2. Obtaining mechanical properties similar to silica-based AR glasses
    3. Developing an IP glass composition suitable for industrial manufacturing and demonstrating the 40-60% lower energy consumption

## PROJECT PLANS AND PROGRESS

11. **Past Accomplishments:** IP glass fibers have been manufactured using industrial phosphate waste as raw materials under a DOE SBIR Phase I contract. A family of IP glass compositions was developed with

increased chemical durability in acidic and alkaline solutions. These IP glass fibers are technically and economically competitive with commercial silica-based glass fibers for concrete reinforcing (GFRC) applications. Additional applications have been identified including fiber reinforced polymers (GRFP), glass microspheres, chemically resistant enamels, and high temperature grease additives.

12. **Future Plans:**
    1. Optimize composition of current IP glasses by additions of oxides such as ZrO2, Al2O3, and CaO
    2. Determine critical properties of IP glasses: chemical durability, mechanical testing, viscosity, and sizing parameters
    3. Evaluate industrial manufacturing issues: bushing materials, residence times, effects on refractories, sizing of fibers, and production potential
    4. Evaluation of GFRC: mechanical and environmental characterization
    5. Pilot scale production with industrial partner
    6. Preliminary making and testing of IP glass fibers for GRFP

13. **Project Changes:** An additional task is to evaluate the lab melting procedure for scaling to industrial manufacturing.

14. **Commercialization Potential, Plans, and Activities:** The anticipated product is an IP glass fiber that substitutes commercial silica-based AR glass fibers. The glass fiber is to be fabricated eventually by the glass company partner Advanced Glassfiber Yarns, LLC.

15. **Publications on the Subject:**

**T. M. Neidt**, Recycling of industrial Phosphate Waste as raw Material for Innovative Iron Phosphate Glass Fibers; **Mo-Sci Corp**. Final Report Phase I SBIR Prepared for the US EPA under Cooperative Agreement Contract No. 68-D-03-030, September 2003.

X. Yu, G.J. Long, **R.K. Brow** and **D.E. Day**, "Properties and Structure of Sodium-Iron Phosphate Glasses," J. Non-Cryst. Solids, 215, 21-31 (1997).

F. Chen and **D. Day**, "Corrosion of Selected Refractories by Iron Phosphate Melts," Ceram. Trans. 93 213-220 (1999).

X. Fang, C.S. Ray, G.K. Marasinghe, **D.E. Day**, "Properties of Mixed Na2O & K2O Iron Phosphate Glasses," J. Non-Cryst. Solids 263 & 264 293-98 (2000).

**S.T. Reis**, M. Karabulut, **D.E. Day**, "Chemical Durability & Structure of Zinc-Iron Phosphate Glasses," J. Non-Cryst. Solids 292 150-57 (2001)

A. Mogus-Milankovic, A. Gajovic, A. Santic and **D.E. Day** "Structure of Sodium Phosphate Glasses Containing Al2O3 and/or Fe2O3, Part I," J. Non. Cryst. Solids 289 204-13 (2001)